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SOIL-MOISTURE AND TEMPERATURE TRENDS IN CUTOVER AND ADJACENT OLD-GROWTH DOUGLAS-FIR TIMBER

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INTRODUCTION

Knowledge of soil-moisture variation and its causes is necessary for improving establishment and early growth of regeneration and for developing a better understanding of tree-site relationships in the mixed-conifer zone of southwest Oregon. In the study reported here, seasonal soil-moisture trends on a cutover were compared with those on an adjacent timbered area. Soil temperature was also measured, because the electrical resistance readings used to measure soil moisture must be corrected for temperature.

The purpose of this article is: (1) to report seasonal trends in soil moisture and temperature on a cutover and adjacent timber, (2) to show the importance of low, invading vegetation in depleting soil moisture on a cutover.

STUDY AREA

The study was conducted in the mixed-conifer zone of the South Umpqua drainage at 43°04-1/2' N. latitude and 122°42' W. longitude. Elevation is 2,800 feet. The cutover area was logged in 1957 and the slash was burned in fall of 1958. Intensity of the slash burn varied from unburned to light. Light burn is defined as a burn in which the slash is partially consumed--the litter surface is charred and there are unburned pieces below the surface.

The timber is (or was) an old-growth stand of Douglas-fir *(Pseudotsuga menziesii)*, with scattered grand fir *(Abies grandis)* and

incense-cedar *(Libocedrus decurrens)* trees. Sugar pine *(Pinus lambertiana)* trees are present in the stand but not within the study boundaries. Ground cover of variable density in the uncut stand consists of salal *(Gaultheria shallon)*, Oregongrape *(Mahonia aquifolium)*, western swordfern *(Polystichum munitum)*, and miscellaneous herbaceous plants. There are occasional fir saplings and poles and shrubs.

The vegetation on the cutover was similar in composition and density to that found on many other north-facing cutovers 2 to 5 years after the slash burn. The vegetation density on the cutover area in 1963 varied from medium to heavy. Whitebark raspberry *(Rubus leucodermis)*, deerbrush ceanothus *(Ceanothus integerrimus)*, snowbrush ceanothus *(Ceanothus velutinus)*, western swordfern, bull thistle *(Cirsium lanceolatum)*, grass species, and miscellaneous annual weeds occur as scattered individuals. Dense patches of modest whipplea *(Whipplea modesta)* and salal were present.

The soil varies from a well-drained stony loam to a stony clay at the 36-inch depth, is derived from reddish breccias, and is classified in the tentative Straight[1/] series. The slope varies from approximately 30 to 60 percent. Average annual rainfall for the 3 years reported here was 40 inches at a station 4-1/2 miles south of the study area.

METHODS

Soil moisture was measured with Fiberglas electrical resistance units[2/] at 6-, 18-, and 36-inch depths. Soil temperature was measured with thermistors in the resistance units.

In January 1960, 10 points 1 chain apart--5 in the timber and 5 in the cutover area--were located along a line at right angles to the cutting edge.[3/] Thus, the first point in the timber and the first point in the cutover area were one-half chain from the cutting edge. Resistance units were inserted in the soil at the 6-, 18-, and 36-inch depths on the side of a hole dug with post-hole auger.

[1/] Richlen, E. M. Soil survey report of South Umpqua area of Region 6. In-Service report, U.S. Forest Service, Region 6, Portland, Oreg. 1963.

[2/] Colman, E. A., and Hendrix, T. M. The Fiberglas electrical soil-moisture instrument. Soil Sci. 67: 425-438. 1949.

[3/] Records were also taken for a second line but are not reported here, as the soil for the cutover portion was a different series than for the timber.

Resistance readings were taken usually between 9 a.m. and noon, at 2- or 3-week intervals during spring and summer months of 1960, 1961, and 1963. During winter months, readings were taken at 2- to 6-week intervals, depending on accessibility of the study area. Resistance readings were corrected for temperature and converted to soil-moisture percent from the following calibration equations of soil moisture over logarithm of resistance:

Cutover:

6-inch depth, $y = 76.48 - 12.1736x$

18-inch depth, $y = 64.35 - 9.9159x$

36-inch depth, $y = 54.83 - 7.3842x$

Timber.

6-inch depth, $y = 79.78 - 12.917x$

18-inch depth, $y = 65.65 - 9.6977x$

36-inch depth, $y = 58.17 - 7.1719x$

where x equals logarithm of resistance and

y equals soil-moisture percent

Soil samples for calibration were collected during spring and summer of 1961 at each of the three depths for the 10 sampling points. Quadrant at each location for soil-moisture sample was selected randomly each time. Samples were taken at least 3 feet from the resistance unit in order not to disturb moisture relations at units. Soil moisture is expressed as the percent of ovendry weight of the soil including stones.[4/]

Calibration samples consisted of average soil-moisture content for five sample points and average logarithm of resistance for the corresponding five moisture units. The five points in the cutover and the five points in the timber constituted a sample for each depth.

Results are graphically presented for soil moisture and soil temperature by plotting over time.

[4/] Tests showed that a better estimate of soil moisture was obtained by including the stones, as the stones in this soil hold substantial amounts of moisture.

RESULTS AND DISCUSSION

Soil moisture.--Soil moisture during the growing season is of principal concern in connection with tree growth. The 1960 and 1961 seasons were typical in that there was little precipitation during the usual dry period, whereas in 1963, temperatures were below average and heavy precipitations occurred during the latter part of June.

Soil moisture declined sharply in June at the 6- and 18-inch depths (figs. 1 and 2). In 1960 and 1961, the sharp decline slowed in July and continued at a reduced rate until terminated by fall rains in late August or September. In 1963, late-June rains interrupted the normal decline in soil moisture for 6- and 18-inch depths (fig. 3). Soil moisture increased and a period of rapid decline started again in early July and ended in early September.

At the 36-inch depth, the period of rapid soil-moisture decline did not begin until early July and ended in August or September. Late-June rains in 1963 only slowed the rate of decline.

The most surprising result of this study was the similarity of the soil-moisture depletion rates and minimum soil-moisture contents for the timbered and adjoining cutover area. Bethlahmy[5/] has shown that, in the year following timber harvest but before the cutover has been invaded by competing vegetation, minimum soil-moisture contents have been considerably lower on the timbered areas than on the adjoining cutover area. However, in this study, the vegetation which has invaded the cutover is shown to be as effective as the old-growth stand in depleting soil moisture at the 6- and 18-inch depths and nearly so at the 36-inch depth. Minimum soil moisture at 6 and 18 inches was the same or slightly lower on the cutover than on the timbered area. At the 36-inch depth, the minimum soil moisture was only slightly higher on the cutover area than on the timbered. In a subsequent study[6/] on other cutovers, minimum levels of soil moisture were much lower on areas with vegetation than on adjoining plots from which vegetation had been removed.

During wetting periods, the soil in the timbered area usually was recharged more slowly than in the cutover area, due to precipitation interception by the trees.

[5/] Bethlahmy, Nedavia. First year effects of timber removal on soil moisture. Int. Ass. Sci. Hydrol. Bull. 7(2): 34-38, illus. 1962.

[6/] Hallin, William E. Data in preparation for publication, Pacific Northwest Forest & Range Exp. Sta., U.S. Forest Serv., Portland, Oreg.

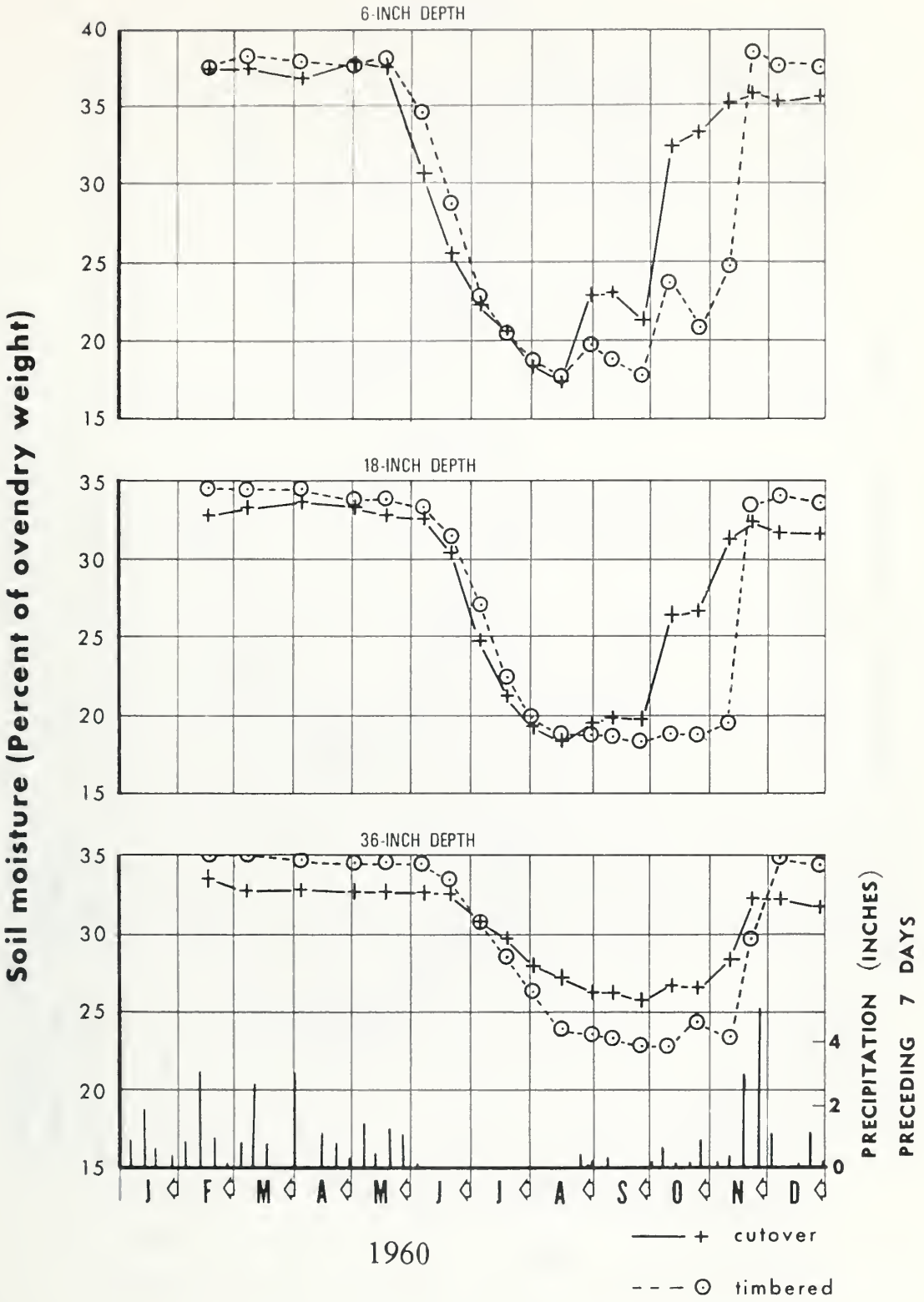

Figure 1.--Soil moisture in cutover and adjacent timber in southwest Oregon, 1960.

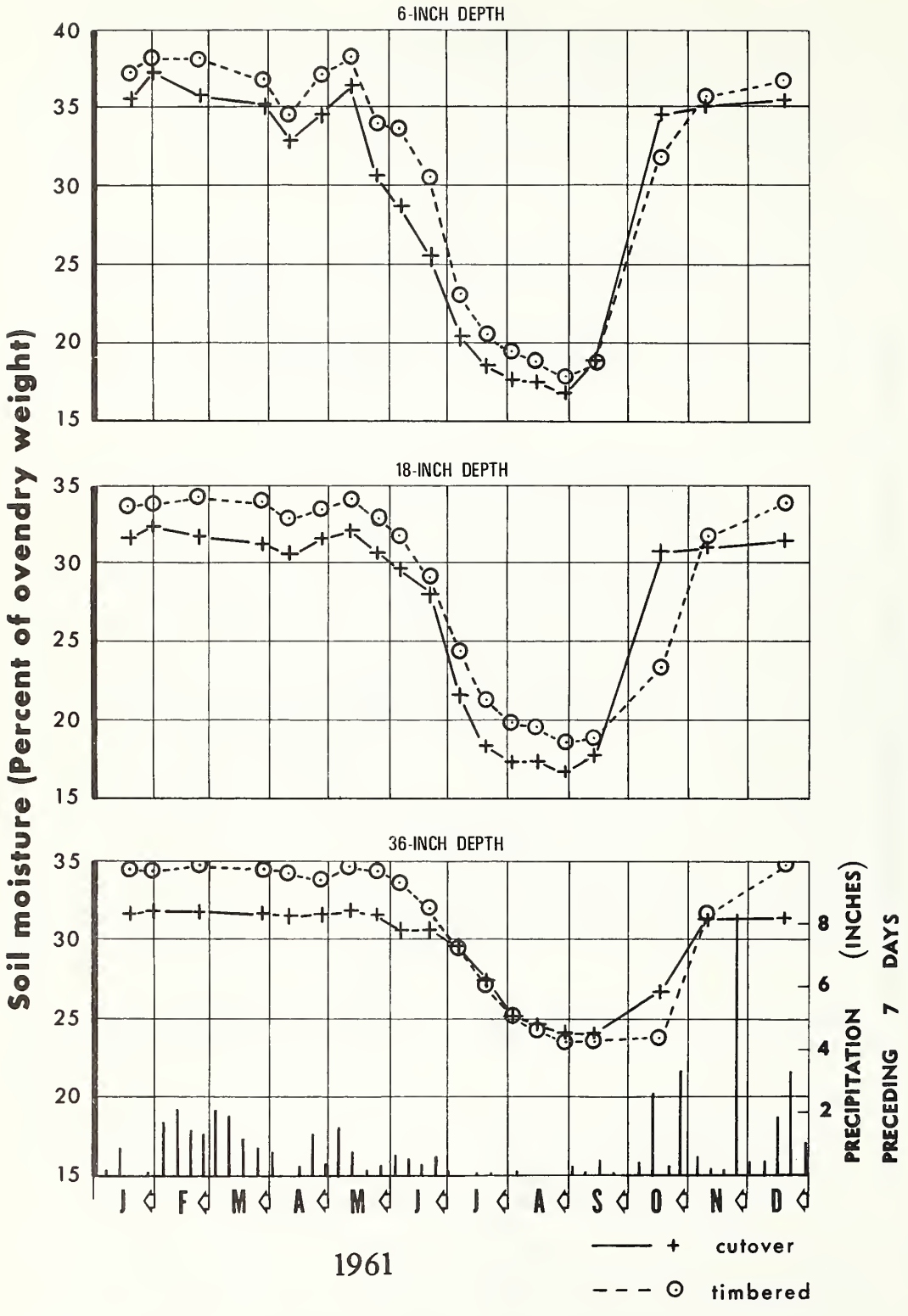

Figure 2.--Soil moisture in cutover and adjacent timber in southwest Oregon, 1961.

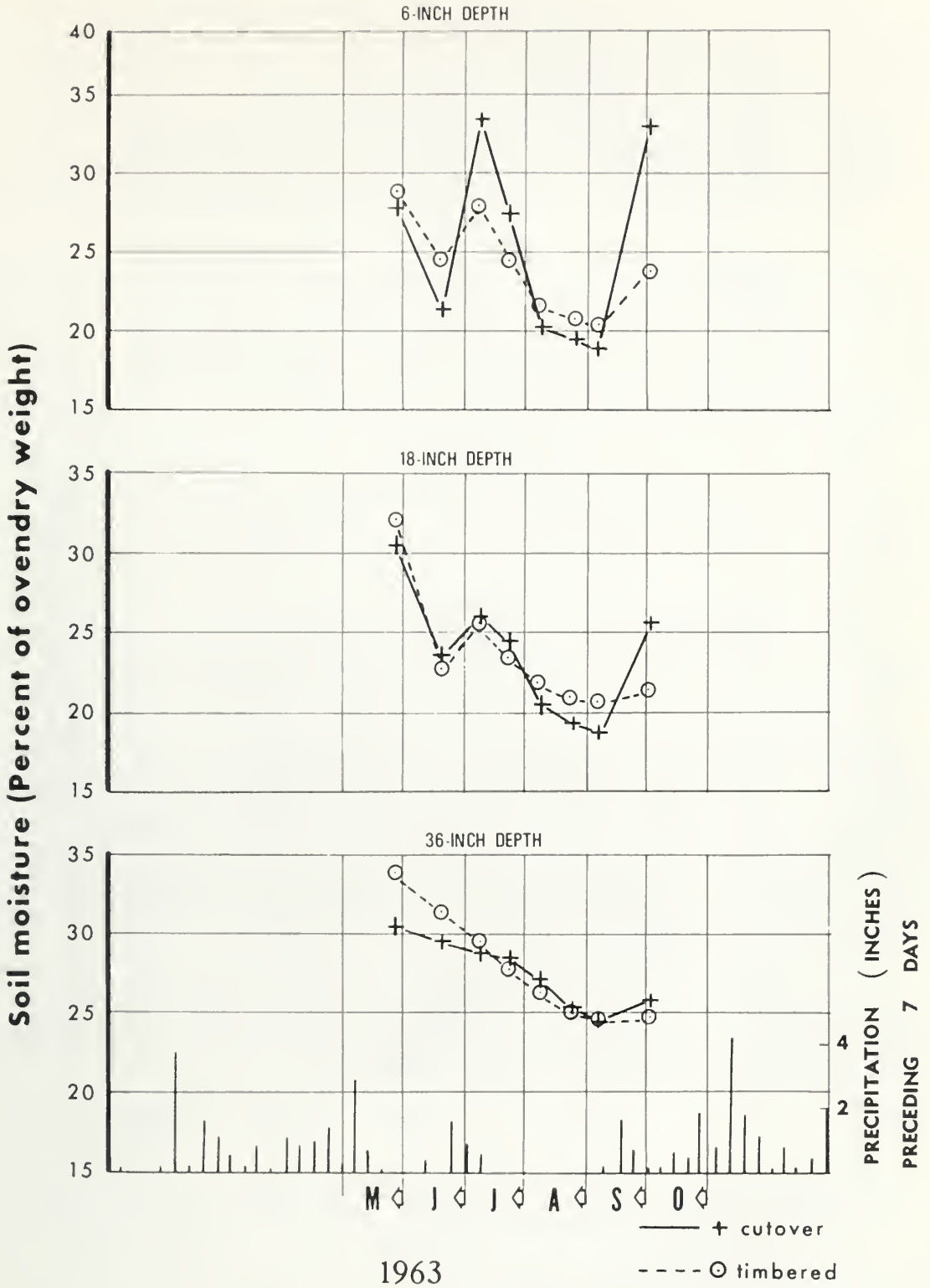

Figure 3.--Soil moisture in cutover and adjacent timber in southwest Oregon, 1963.

Results of this study confirm observational conclusions that vegetation is an important source of moisture depletion on cutover areas. In establishing regeneration, foresters must recognize the heavy drain on soil moisture caused by competing vegetation. The need for prompt establishment of regeneration after cutting before competing vegetation invades the cutover is again emphasized. Control of competing vegetation on many areas to permit establishment of regeneration or release of existing regeneration is also necessary.

Although fertilizing forest areas for increased growth is becoming an accepted practice in some areas, many foresters question its practicability in southwestern Oregon because of supposed lack of adequate soil moisture. The soil-moisture trends reported here show that, even though ultimate summer soil-moisture levels may be quite low, substantial amounts of moisture are present well into June and even to the end of June for the 18- and 36-inch depths. Consequently, soil-moisture levels during the early part of the growing season may be adequate for successful use of fertilizer for increasing growth, despite the dry summer climate in southwestern Oregon. Therefore, research is needed to determine whether or not there is adequate soil moisture for successful use of fertilizer on forest land in southwestern Oregon.

Soil temperatures.--Soil temperatures were similar in 1960 and 1961 (figs. 4 and 5); whereas, in the summer of 1963 (fig. 6), they generally were 3° to 5° F. lower than in 1960 and 1961.

On August 20, 1964, temperatures were measured at approximately 2-hour intervals between 7:30 a.m. and 5 p.m. at each of the three depths for the 10 sampling points. Maximum air temperature was 82° F. At the 18- and 36-inch depths, there was no temperature change. At the 6-inch depth, temperature increased only 1° in the timber and 2° on the cutover. Consequently, there probably was no diurnal variation from temperatures reported here for 18- and 36-inch depths, and only a few degrees' variation at most for the 6-inch depth.

Very little is known about temperature requirements for root growth of western conifers. The temperature data is presented as a record of seasonal change in soil temperature primarily for use with results of future research on root growth.

SUMMARY

Seasonal trends in moisture and temperatures are reported for 6-, 18-, and 36-inch soil depths for the years of 1960, 1961, and 1963 on a timbered and adjoining area which was cutover in 1957 and burned in the fall of 1958. Soil moisture on the cutover area was similar to that for the timbered area, thus indicating a nearly equal moisture drain by lesser vegetation on the cutover area.

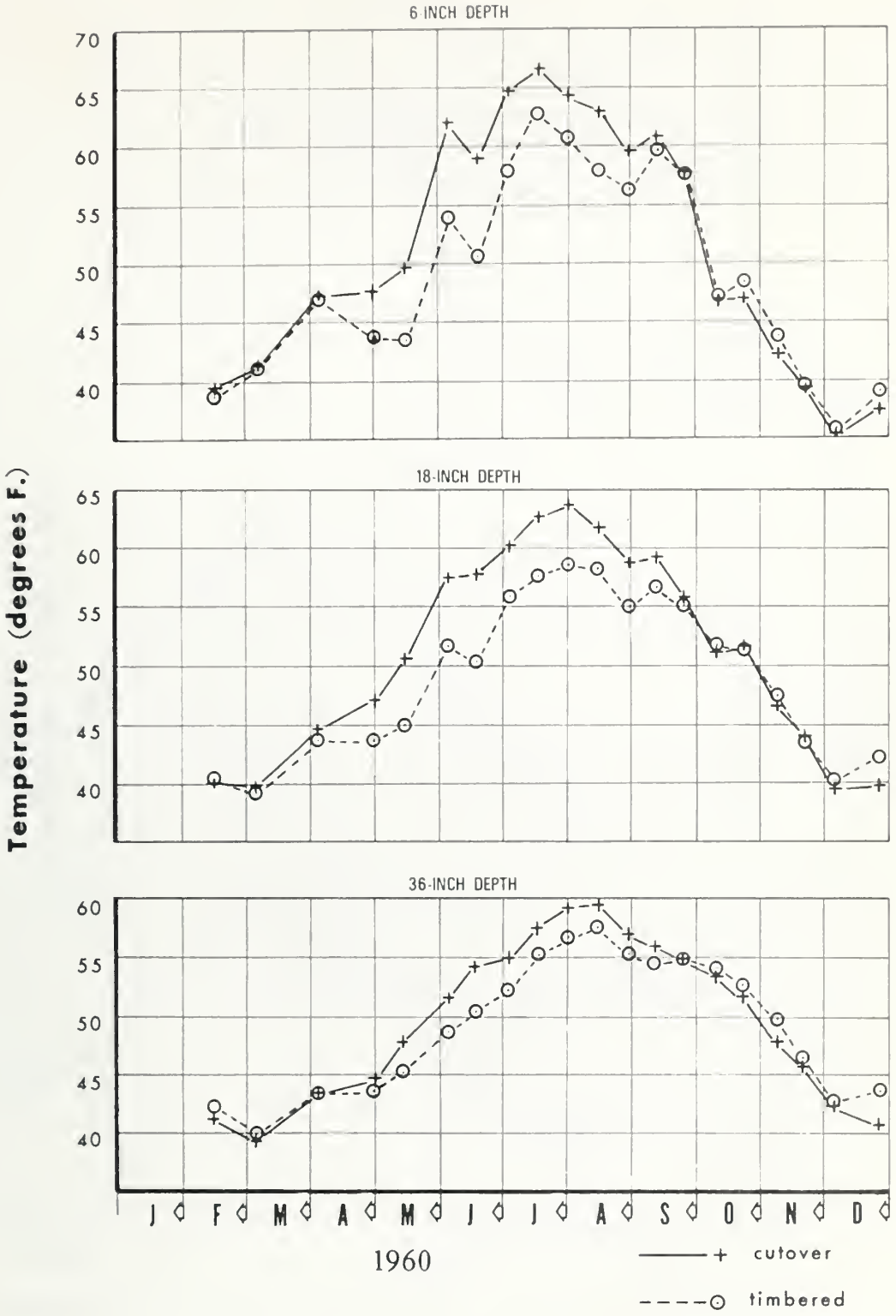

Figure 4.--Soil temperature in cutover and adjacent timber in southwest Oregon, 1960.

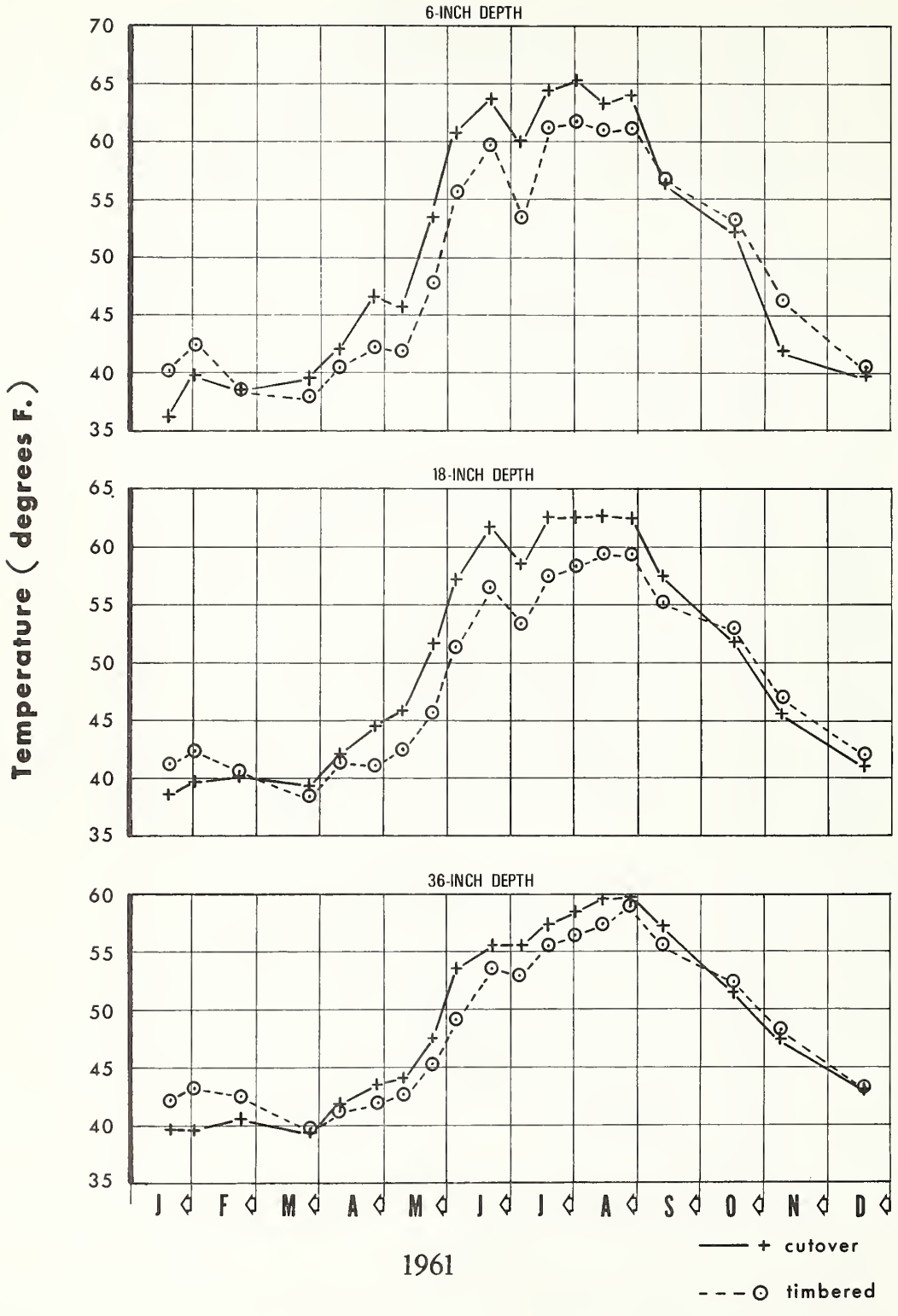

Figure 5.--Soil temperature in cutover and adjacent timber in southwest Oregon, 1961.

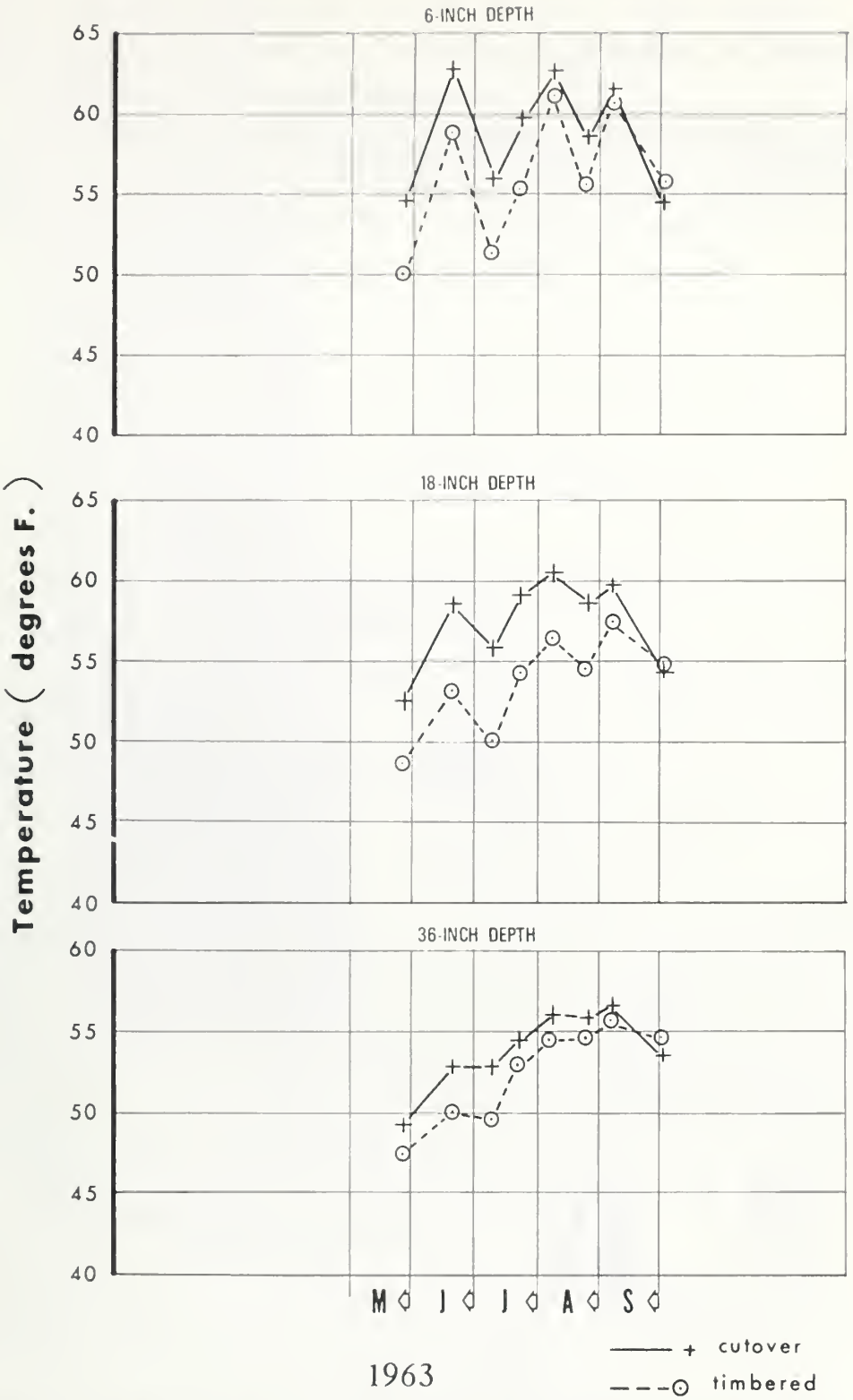

Figure 6.--Soil temperature in cutover and adjacent timber in southwest Oregon, 1963.